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SPECIFICATION

1. Title of the Invention: MAGNETIC MEDIUM AND METHOD FOR MANUFACTURING THE SAME

2. Claims

(1) A magnetic recording medium, comprising: a substrate; an underlayer having conductivity and electrochemical stability on one or both surfaces of the substrate; and a magnetic recording layer including an anodized layer formed of aluminium or an aluminium alloy and a magnetic material, the anodized layer having plenty of pores formed by anodic oxidation whose depth is substantially equal to the thickness of the anodized layer, the pores being filled with the magnetic material.

(2) A magnetic medium according to Claim 1, wherein the substrate is formed of a nonmagnetic metal or an organic polymer.

(3) A magnetic medium according to Claim 1, wherein the underlayer comprises at least one selected from the group consisting of Rh, Nb, Ta, Au, Ir, Pt, Ti, Cr, Pd, Ru, Os, Ga, Zr, Ag, Sn, Cu, Hf, and Be.

(4) A magnetic recording medium according to Claim 1, wherein the thickness of the underlayer is 200 Å or more.

(5) A magnetic recording medium according to Claim 1, wherein the thickness of the magnetic recording layer is 5000 Å or less.

(6) A method for manufacturing a magnetic recording medium, comprising the steps of: forming a conductive, electrochemically stable underlayer on a substrate; forming an aluminium layer or an aluminium alloy layer on the underlayer; anodizing the aluminium layer or the aluminium alloy layer to form an anodized aluminum layer having pores, using the underlayer as an electrode; increasing the diameter of t he pores in the anodized aluminium layer by electrolysis; and filling the enlarged pores with a magnetic material.

3. Detailed Description of the Invention

[Technical Field]

The present invention relates to magnetic recording media and methods for manufacturing the same, and particularly to a magnetic recording medium having a

magnetic recording layer in which a magnetic material is deposited in pores formed by anodizing aluminium or an aluminium alloy, and to a method for manufacturing the magnetic recording medium.

[Related Arts]

Perpendicular magnetic recording is one promising method for high density recording, and has been studied with particular emphasis on a Co-Cr perpendicular magnetic film. On the other hand, it has been found that an anodized aluminium film formed by anodizing an aluminium surface or an aluminium alloy and electrodepositing a magnetic metal has an easy magnetization axis perpendicular to the surface thereof and, therefore, has a possibility as a perpendicular recording medium (Japanese Patent Publication No. 51-15597; S. Kawai et al, J. Electrochem. Soc. 122 (1975) pp32).

In anodic oxidation of aluminium or aluminium alloy, an aluminium or aluminium alloy plate is conventionally used as an electrode, and is anodized in a solution of sulfuric acid, oxalic acid, chromic acid, or the like.

[Problems to be Solved by the Invention]

However, when plenty of pores are formed in an anodized aluminium layer by anodizing the surface of the aluminium or aluminium alloy plate, the pores vary in depth; hence, the depth of the pores in the plate becomes extremely nonuniform. Also, when plenty of aluminium or aluminium alloy plates are

anodized at one time, the pores formed in the anodized aluminium layer of each plate have different depths.

In general, the coercive force of a magnetic recording medium is determined according to the length ratio of a short axis (corresponding to the pour diameter) to a long axis (corresponding to the pore depth) of a magnetic portion deposited in the pores. Therefore, varied pore depths lead to a nonuniform coercive force, as a matter of course.

Furthermore, the diameter of the pores formed by the anodic oxidation is generally very small, 200 Å or less, and excessively increases the coercive force of the magnetic anodized aluminium film. This makes it difficult to erase data from magnetic recording media, which are required to repeat recording and erasing. Accordingly, methods for increasing the pore diameter to reduce the coercive force to a value suitable for perpendicular recording have recently been proposed (Japanese Patent laid-Open No. 59-207029 et al).

However, since the pore depth itself varies, variation in magnetic recording properties results inevitably, even if the pore diameter is increased.

One object of the present invention is to provide a magnetic recording medium having an anodized aluminium layer having pores with a uniform depth and magnetic recording layer having uniform magnetic recording properties and to

provide a method for manufacturing the magnetic recording medium, and, thus, to solve the above-described problems.

[Means for Solving the Problems]

The above-described object can be achieved by providing a magnetic recording medium comprising a substrate; an underlayer having conductivity and electrochemical stability on one or both surfaces of the substrate; and a magnetic recording layer including an anodized layer formed of aluminium or an aluminium alloy and a magnetic material. The anodized layer has plenty of pores formed by anodic oxidation whose depth is substantially equal to the thickness of the anodized layer. The pores are filled with the magnetic material. The magnetic recording medium is manufactured by the steps of: forming a conductive, electrochemically stable underlayer on a substrate; forming an aluminium layer or an aluminium alloy layer on the underlayer; anodizing the aluminium layer or the aluminium alloy layer to form an anodized aluminum layer having pores, using the underlayer as an electrode; increasing the diameter of the pores in the anodized aluminium layer; and filling the pores with a magnetic material

[Embodiments]

Fig. 1 is a sectional view of a magnetic recording medium according to an embodiment of the present invention.

In Fig. 1, a conductive, electrochemically stable

underlayer 2 is formed on a substrate 1. An anodized aluminium layer 3 is formed on the underlayer 2 by anodizing aluminium or an aluminium alloy. The anodized aluminium layer 3 has pores 4 filled with a magnetic material 5.

In order to advantageously use the magnetic recording medium for magnetic tapes, floppy disks, and the like, the substrate 1 is formed of an organic polymer and the anodized aluminium layer 3 has a small thickness.

Organic polymers which may preferably be used here include polyethylene terephthalate (PET) and polyimide. Alternatively, Al or Cu may be used for the substrate 1.

The underlayer 2, which is formed on the substrate 1, may be disposed on one surface or both surfaces of the substrate 1. The underlayer 2 is electrochemically stable, and easily forms a passive film in an acidic or alkaline solution. The underlayer 2 may be formed by any method, such as vacuum deposition or sputtering. Preferably, the thickness of the underlayer 2 is set 200 Å or more, in order to give the underlayer conductivity and functions of staying reaction.

The underlayer 2 contains at least one selected from the group consisting of Rh, Nb, Ta, Au, Ir, Pt, Ti, Cr, Pd, Ru, Os, Ga, Zr, Ag, Sn, Cu, Hf, and Be. These metals are stable against anodic oxidation of aluminium or an aluminium alloy and, therefore, maintain the layered structure thereof

and the predetermined shape of the anodized aluminium layer.

The anodized aluminium layer 3 disposed on the underlayer 2 is formed by anodizing aluminium or an aluminium alloy. In this instance, the anodized aluminium layer 3 is obtained by anodizing aluminium or an aluminium alloy having a thickness equal to a required depth of pores ultimately formed therein.

Specifically, if aluminium or an aluminium alloy having a thickness of 5000 Å or less is used, the thickness of the anodized aluminium layer 3 formed by anodic oxidation of the aluminium or aluminium alloy can be set at substantially 5000 Å or less. Thus, the depth of the pores formed during the anodic oxidation can also be set at 5000 Å or less and equal to the thickness of the anodized aluminium layer 3. The diameter of the resulting pores 4 having a uniform depth is increased by electrolysis, and thus the pores can have a relatively large diameter while maintaining the uniformity in depth.

In this instance, the pore diameter is varied depending on the pore depth, but preferably it is in the range of about 200 to 1000 Å.

Next, the pores 4 whose diameter was increased is filled with the magnetic material 5. The magnetic material 5 may be Fe, Co, Ni, or an alloy of these metals.

Example 1

Nb was deposited at a thickness of 1000 Å on a polyethylene terephthalate (PET) film of 110 mm in width and 50 μm in thickness by vacuum deposition using an electron gun. Furthermore, Al was deposited at a thickness of 3000 Å on the Nb layer.

In the Al deposition, the mask width was set so that the area of the Nb layer would become larger than the area of the Al layer. Then, the Nb layer was connected to an electrode, and was subjected to anodic oxidation in 3% of oxalic acid solution and subsequently to electrolysis in the solution mixture of 5% of sulfamic acid and 1% of phosphoric acid to increase the diameter of the pores in the anodized aluminium layer. Then, Fe was deposited in the pores.

The cross section of the resulting magnetic recording medium was observed by SEM (scanning electron microscopy). As a result, it was shown that Fe filled the pores from the surface of the anodized aluminium layer to the surface of the Nb layer.

Next, the magnetic properties of the resulting magnetic recording medium were observed by VSM (vibrating sample magnetometry). The results are shown in Table 1. Table 1 suggests that the magnetic recording medium has excellent properties of being able to serve as a perpendicular magnetic film.

Table 1

Hc (Oe): coercive force

Mr (emu/cc): maximum residual magnetization

Ms (emu/cc): maximum saturation magnetization

⊥: perpendicular direction

″: parallel direction

Comparative Example

Mg was deposited at a thickness of 1000 Å on a polyethylene terephthalate (PET) film of 110 mm in width and 50 μm in thickness by vacuum deposition using an electron gun. Furthermore, Al was deposited at a thickness of 3000 Å on the Mg layer.

In the Al deposition, the mask width was set so that the area of the Mg layer would become larger than the area of the Al layer. Then, the Mg layer was connected to an electrode, and was subjected to anodic oxidation in 3% of oxalic acid solution.

However, the Mg layer dissolved and partly separated from the PET film during the anodic oxidation, and thus the anodic oxidation could not be completed.

Examples 2 to 18

Magnetic recording media were formed in an identical manner to Example 1 except that Nb was replaced with metals shown in Tables 2 and 3.

The cross sections of the magnetic recording media were observed by SEM. As a result, it was shown that, in any

cases using one of those metals, the pores were filled from the surface of the anodized aluminium layer to the surface of the underlayer.

Next, the magnetic properties of the resulting magnetic recording media were observed by VSM. The results are shown in Tables 2 and 3. These Tables suggest that the magnetic recording media have excellent properties of being able to serve as perpendicular magnetic films.

Table 2

Table 3

As described above, since the magnetic recording medium according to the present invention has a conductive, electrochemically stable underlayer on a substrate and an anodized aluminium layer containing a magnetic material on the underlayer, the depth of pores formed during anodic oxidation can be controlled by setting the thickness of an aluminium or aluminium alloy layer, and thus, a uniform depth can be achieved. Therefore, by increasing the pore diameter, pores having a desired diameter and a uniform depth can be achieved.

4. Brief Description of The Drawings

Fig. 1 is a sectional view of a magnetic recording medium according to an embodiment of the present invention.

1: substrate, 2: underlayer, 3: anodized aluminium

layer, 4: pore, 5: magnetic material